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By

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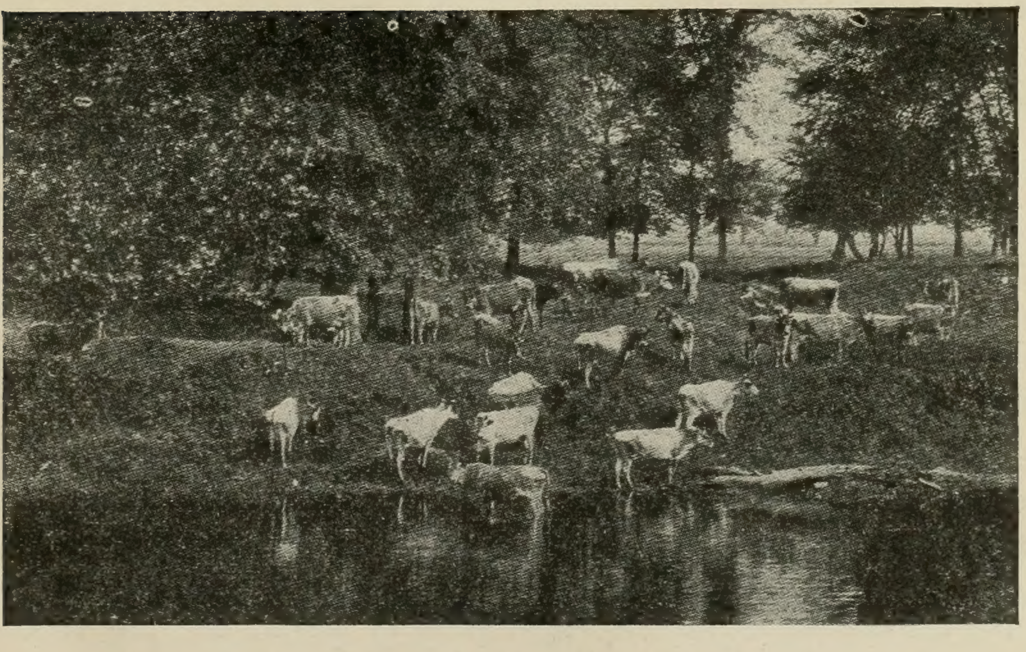

THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO
AGRICULTURAL COLLEGE EXTENSION SERVICE
CLARK S. WHEELER, *Director*

THE FEEDING OF DAIRY COWS

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Ohio has 675,000 dairy cows that are producing on the average of less than 160 pounds of butter fat a year. An important cause for this low butter fat production can, no doubt, be attributed to improper feeding. Since the cow produces milk and butter fat, largely in accordance to the quantity and kind of feed that she eats, it is necessary that she be supplied with the proper nutrients. Feeds vary in composition and in the percentage of the various digestible nutrients. Successful feeding requires a knowledge of the composition of feeds, the requirements of cows and the methods of combining feeds so that they will meet those requirements.

COMPOSITION OF FEEDS

All feeds, used in the feeding of dairy cows, are composed of the following constituents: water, carbohydrates, fats, fiber, protein and ash, or mineral matter. Each of these constituents function in some way in the nutrition of an animal.

Water.—Water is present in all feeds in varying amounts. Some feeds, such as crib-dry corn, contain about 14 percent of water; silage contains such a high percent of water that it can readily be detected. Water is an important part of the animal body and has a prominent place in animal life. It is necessary, in order that the processes of digestion may go on properly, that the intestines be flushed, the blood be kept liquid and the body temperature be kept normal. Continued lack of water causes great disturbances in all bodily functions and unless supplied frequently will cause death.

Carbohydrates.—The carbohydrates are the important parts of most feeds. They are that class of feed constituents composed of starches and sugar. Starch is the principal carbohydrate and makes up most of the white of the corn kernel. Sugar is found in only a few of the mature plants, such as sugar beets or sorghum. The function of the carbohydrates is to produce heat or energy in the animal body, but from them the animal can form body fat if necessary.

Fats.—Fats, or plant oils, are found principally in the seeds. Such seeds, as flax seed or cotton seed are nearly one-third fat while others contain very little fat. Corn is a feed that carries a fairly large amount of fat; it averages about 4.3 percent of fat. Fats are used in the animal body for much the same purpose as are the carbohybrates; the production of heat or energy, or the formation of body fat. When fat is burned it gives off about two and one-fourth times as much heat as carbohydrates. It is therefore estimated that fats are two and one-fourth times as valuable in producing heat and energy in the animal body as are the carbohydrates.

Fiber.—In nearly all feeds there is some fiber, or woody material. Fiber has about the same composition as the carbohydrates, but it is not digestible to such an extent as to make it of value as a feed nutrient. A feed may contain so much fiber as to make it of but little value. Most of the fiber is found in the stems or stalks of plants and mature plants contain more fiber than do young plants. Coarse hays and corn stover contain much fiber. The grains contain fiber, but in rather small amounts. Oats, however, contain a good deal of this substance.

Protein.—Besides the carbohydrates and fats of feeds, there is another constituent of much value known as protein. It differs from the other constituents in that it contains nitrogen. Protein is the only feed constituent from which the red flesh of the body can be formed. It is also an important part of all tissues, blood, hide, hair and milk. Since it is impossible for any other substance to take the place of protein in the nutrition of the animal, we at once see the important part that it plays. In the case of carbohydrates and fats, one can replace the other to a limited extent, and under certain conditions, protein may serve the purpose of the carbohydrates and fats. Thus we see that the supply of these nutrients in proper proportions is not so important as the supply of protein.

Protein is not found in large amounts,in the usual farm grown grains, so, in dairy cattle feeding, it is often necessary to purchase feeds, such as cotton-seed meal or oil meal, to supply protein. Among the roughages, the legumes, alfalfa and clover, are the principal bearers of protein. These plants have, through bacteria that live on their roots, the power to convert the nitrogen of the air into plant protein. Since plant protein is a very expensive feed constituent these plants are very valuable as home grown feeds.

Ash.—Ash, or mineral matter, is the material left after a feed is burned and is chiefly lime and phosphorus. All feeds contain some mineral matter. It is used particularly in the building up of the bony structure of the body, but is important in other ways also. The dairy cow in particular must be supplied with mineral matter, for each day she gives from her body, in the milk, a certain amount of this material. Corn is low in mineral matter and the clovers and alfalfa carry much of it. Ordinarily, with a good ration containing several different feeds, one will supply sufficient mineral material for the needs of the cow, so this is not given a great deal of attention in feeding.

COMPOSITION OF MILK

Milk is composed of five different materials in the following proportions: water 87 percent, fat 4 percent, protein 3.5 percent, sugar 4.8 percent, and ash .7 percent. The fat that is in the milk is similar in composition to the fat of the animal body. The protein has the same composition as the lean meat, or muscles, of the body and the sugar of milk is similar to the fats in that it is made up of the same materials only in different proportion. The mineral matter or ash is the same in composition as the bones of the body. All of these milk constituents are carried in solution in the water which is the main constituent of milk.

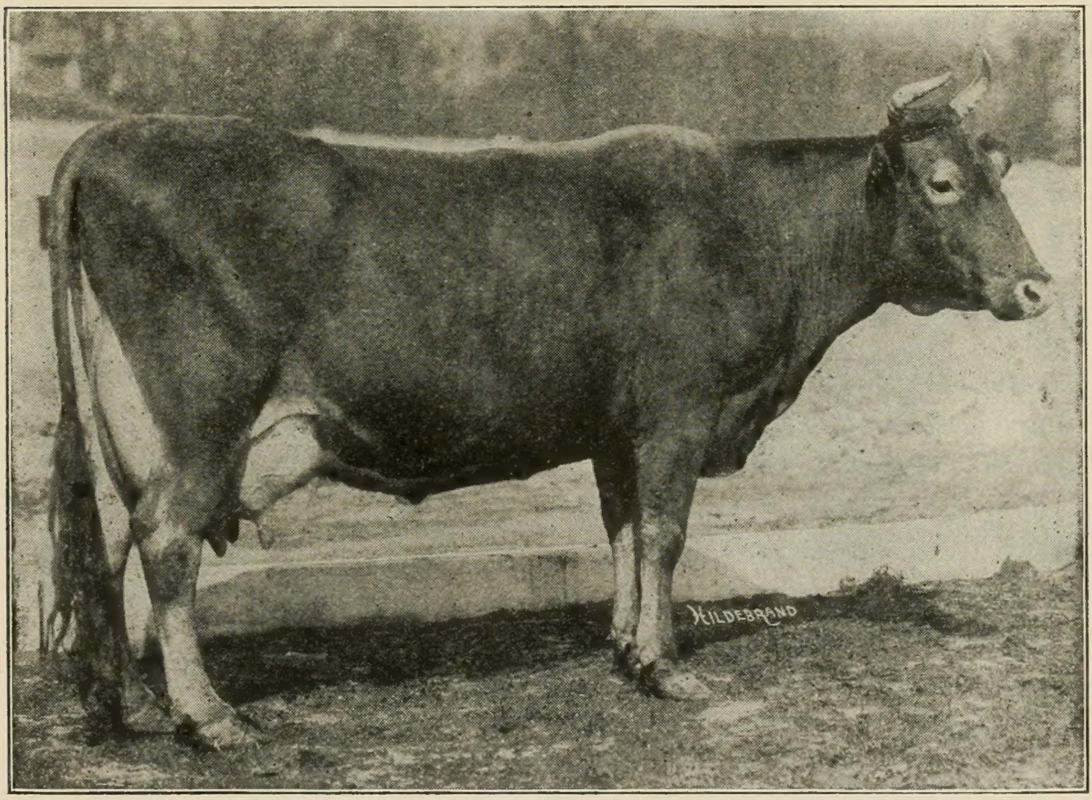
Milk is secreted in the udder of the cow, but the process of secretion is not entirely understood. In some way the cow takes the digested feed materials, and transforms them into milk. With the knowledge that the constituents of milk are similar to the same constituents of the animal's feed, we can readily see why we should supply these materials to the cow. In order that she may produce abundantly, she must have the necessary materials to form the milk. These materials are the protein, carbohydrates, fats and minerals of the feed stuffs, and water.

DIGESTIBLE NUTRIENTS

We have seen that all feeds are composed of protein, carbohydrates and fats and that these are needed to build up the body of the growing animal and also for milk production in the mature cow. It has been found, by experimenting, that the animal can digest only a part of each of these nutrients, and that this varies a great deal according to the feed. We, therefore, find it important to know whether or not the feed is digestible as well as to know its composition. The chemist can tell us the composition of a feed, but only experiments with animals can tell us of its digestibility. The digestible part of a feed is that part retained by the animal body; the undigested part makes the manure.

NUTRITIVE RATIO AND BALANCED RATIONS

In general the constituents of a feed can be classed in two groups, the nitrogenous and non-nitrogenous. In the first group is protein, as it is the only one containing nitrogen. In the second group are the carbohydrates and fats, as they contain no nitrogen. It has been found that animals need the feed nutrients in certain proportion to meet the body requirement and to give good returns for the feed consumed. Carbohydrates and fats form fat in the body and supply heat and energy for all the body activities, while protein forms the red flesh or muscular structures.



Murne Cowan, an Ohio cow that was a recent world's champion butter producer. Her record, 1372 pounds of butter in one year, was made possible by proper feeding.

The ratio of the nitrogenous to non nitrogenous nutrients is called the nutritive ratio. Protein and carbohydrates have the same value in forming heat or energy, while fat has two and one-fourth times as much heat value as either of these. By multiplying the fat by two and one-fourth and adding the result to the carbohydrates, we get the heat value of the non-nitrogenous nutrients. If we now divide this by the protein we have the nutritive ratio of the feed.

One hundred pounds of corn contain 7.8 pounds of protein, 66.8

pounds of carbohydrates, and 4.3 pounds of fat and has a nutritive ratio of 1:9.67. The method of determining the nutritive ratio is as follows:

$4.3 \times 2\frac{1}{4} = 8.675$
$66.8 + 8.675 = 75.475$
$75.475 \div 7.8$ (protein) $= 9.67$. Nutritive ratio 1:9.67

Balanced rations are rations that supply the animal with sufficient feed and that have the nutrients in correct proportions. This is usually brought about by using several feeds together, but might be accomplished with one feed. When a ration has the proper balance, it has the correct amount of protein as compared to the carbohydrates and fats. This is found to be true by figuring the nutritive ratio of the feed. When more than one feed is used in a ration, the digestible protein, carbohydrates and fats of each feed are added together and the nutritive ratio of these totals is found the same as in the case of a single feed.

FEEDING STANDARDS AND THE COMPUTING OF RATIONS

Feeding standards are tables that guide one in compounding balanced rations. These standards have been formed after years of investigations with animals. When complete they indicate the amount of digestible protein, carbohydrates and fats to be fed for the maintenance of the body and the production of milk. Following are tables of standards for maintenance of cows of different weight and for production of milk of various fat contents.

TABLE I

NUTRIENTS NECESSARY FOR THE MAINTENANCE OF COWS FOR 24 HOURS

Weight of Cow	Protein Pounds	Carbohydrates Pounds	Fats Pounds
800	.56	5.6	.08
900	.63	6.3	.09
1000	.70	7.0	.10
1100	.77	7.7	.11
1200	.84	8.4	.12
1300	.91	9.1	.13
1400	.98	9.8	.14

TABLE II

NUTRIENTS FOR PRODUCTION OF MILK

	Protein Pounds	Carbohydrates Pounds	Fats Pounds
Each pound of 3 percent milk produced requires	.04	.19	.015
Each pound of 4 percent milk produced requires	.047	.23	.018
Each pound of 5 percent milk produced requires	.051	.27	.021
Each pound of 6 percent milk produced requires	.057	.31	.024

In order to know the amount of nutrients to feed a cow, one should know the weight of the cow, the amount and the fat content of the milk produced. He would then proceed to form the standard as follows. We will consider that the cow to be fed weighs 1200 pounds and produces 30 pounds of 4 percent milk each day. The first thing to do is to find the nutrients required for milk production. By the table we find that 1 pound of 4 percent milk requires .047 pound of digestible protein, .23 pound of digestible carbohydrates and .018 pound of digestible fats. Then 30 pounds will require as follows:

30×.047=1.41 pounds of protein
30×.23 =6.9 pounds of carbohydrates
30×.018= .54 pounds of fats

Now find the nutrients needed for a 1200 pound cow in Table I and add the amounts to those just given.

	Protein Pounds	Carbohydrates Pounds	Fats Pounds
Maintenance nutrients for a 1200 pound cow	.84	8.4	.12
Nutrients for producing 30 pounds of 4 per cent milk..............................	1.41	6.9	.54
Total nutrients needed.....................	2.25	15.3	.66

Now that the feeding standard has been found, the next thing is to select the feeds and balance the ration. It is best to select at least two good roughages, or coarse feeds. Since corn silage and clover hay are common dairy roughages we will take them to start the ration.

From the discussion of corn silage, given on another page, we find that it contains 1.5 percent of protein, 14 percent of carbohydrates and .7 percent of fats. Since we will feed 40 pounds of silage per day, we will now multiply this amount by the percentage amount of each nutrient in it, in order to find the number of pounds of each nutrient in the day's feed, or 40 pounds. The same process should be applied to the 10 pounds of clover hay to be fed.

.015×40= .60 pounds of protein
.140×40=5.60 pounds of carbohydrates
.007×40= .28 pounds of fat

For concentrates we will use 5 pounds of corn meal, 3 pounds of bran and 3 pounds of ground oats. In the discussion of each, we find the composition given below.

	Protein Percent	Carbohydrates Percent	Fats Percent
Corn meal	7.8	66.8	4.3
Bran	11.9	42.	2.5
Oats	8.8	49.2	4.3
Clover hay	7.1	37.8	1.8

The nutrients in the amounts of each of these to be fed should be found as with corn silage. Following is the ration worked out.

	Protein Pounds	Carbohydrates Pounds	Fats Pounds
40 pounds of silage	.600	5.600	.280
10 pounds of clover hay	.710	3.780	.180
5 pounds of corn meal	.390	3.340	.215
3 pounds of bran	.357	1.260	.075
3 pounds of oats	.264	1.476	.129
Total nutrients	2.321	15.456	.879
Standard found	2.250	15.300	.660

The nutritive ratio of the standard is 1:7.51 and that of the ration is 1:7.5. This is close enough. If the ration carries too much or too little protein some constituent must be lowered or raised until the requirement is met.

FEEDING STUFFS

There are two general kinds of feeds, concentrates and roughages. The concentrates are made up of those feeds that contain a large amount of nutrients in a small bulk. The grains and mill products represent this class. The other feeds, the roughages, are those which are of much bulk, such as the hays and fodders.

The concentrates can be divided into those that are high in protein and those that are medium to low. Likewise the roughages may be classed in the same manner. Of the high protein concentrates we have gluten feed, dried brewers' grains, dried distillers' grains, oil meal and cottonseed meal. These contain from 20 to 38 percent of protein. Those classed as medium to low concentrates are bran, oats, rye, barley, corn meal and corn-and-cob meal. These have from 4 to 12 percent of protein.

There are two feeds that are usually called high protein roughages, alfalfa and the clovers. Those that are low in protein are silage, timothy hay, oat hay, corn stover, oat straw and wheat straw. The roughages, except silage, that are classed as low in protein, should not be used as dairy feeds except to supplement the other roughages for night feeds.

Concentrates.—**Corn** is the great feed of the central part of this country. There is no home-grown feed that will give as large a return in nutrients for the space used as will this cereal. Since it is a low protein feed and one that is high in carbohydrates and fats, it is a great energy producer and fat former. Used as the basis of the dairy ration, it is an economical and efficient feed. It contains 7.8 percent of protein, 66.8 percent of carbohydrates and 4.3 percent of fat. Very often the corn and cob are ground together for dairy cows. This results in a more bulky feed which has a great deal more fiber in it. The amount of protein is also lowered materially.

The composition of corn-and-cob meal is 4.4 percent protein, 60.0 percent carbohydrates, and 2.9 percent of fat.

Oats are a much used feed in this state and are grown extensively in the northern part where they usually produce a little more grain to the acre than they do in the central and southern parts. For dairy cows, they are a first class feed, but are often too high in price to be used to any extent. It often becomes a matter of good business to sell the oats and buy some other concentrate. Oats contain quite a little fiber, but not enough to injure their value. They are higher in protein than corn and contain nearly as much fat. Their composition is protein 8.8 percent, carbohydrates 49.2 percent, and fats 4.3 percent.

Barley is a grain not much raised in Ohio today. It is a feed that makes an excellent substitute for corn. It contains a little more protein and more fiber than corn. It is not considered as palatable as corn, but when mixed with other feeds is satisfactory. It contains protein 8.4 percent, carbohydrates 65.3 percent, and fats 1.6 percent.

Rye is another grain not much grown in Ohio. Where it is grown it is more profitable to dispose of it and purchase some feed in its place. When not marketable it may be used in the ration of dairy cows with good results. It contains protein 9.5 percent, carbohydrates 69.4 percent, and fats 1.2 percent.

Bran is the last of those named as feeds that were not high in protein. It is one of the standard dairy feeds. Bran is made from wheat in the process of the manufacture of flour. It is the outer part of the wheat kernel and contains the most of the mineral matter of the wheat grain. It is bulky and light, so makes an excellent material with which to lighten up the grain ration. Bran is a mild laxative, which makes it especially valuable to feed cows just after they have calved and are in a feverish condition.

It contains 11.9 percent of protein, 42 percent of carbohydrates, and 2.5 percent of fat.

Cottonseed meal is the highest carrier of protein that is fed to dairy cows. It is made from the seeds of cotton by crushing, heating and pressing them until the oil has been removed. The product is then ground into meal. For dairy cows, this feed has been found very satisfactory in amounts up to 3 or 4 pounds a day. The composition is protein 35.8 percent, carbohydrates, 23.2 percent, and fats 8 percent.

Oil meal is made from flax seed. The oil of the seed is pressed out as in the case of the cottonseed meal or it is dissolved out through the use of naptha. The first process is known as *old process* meal while that made by the second method is known as *new process* meal. The old process meal is considered the better and is the kind used the most. The best way to feed oil meal is to use the crushed cake. Ordinarily this is harder to buy in small towns than is the meal. There is no feed that is so beneficial as oil meal in the effects that it has on the nutrition of the animal. It causes, when used carefully, a very sleek appearance to come to the coat of the animal. It is slightly laxative and has a very great use in feeding cattle that are generally on dry feed. Since it is very high in its content of protein and fat, it can be easily overfed, which is disastrous. It may be used in amounts up to about 3 pounds in average milk productions.

The composition of the old process meal is 30.2 percent of protein, 32 percent of carbohydrates and 6.9 percent of fat.

Dried distillers' grains are made from corn or rye in the manufacture of alcohol. After the alcohol has been distilled off, there is a watery material left, which when dried is known as dried distillers' grains. The grains from corn are considered to be of more value to feed than those from rye. They are high in protein and contain a fair amount of fat. The composition is protein 22.8 percent, carbohydrates 39.7 percent, and fats 11.6 percent.

Dried brewers' grains are made from barley in the manufacture of malt and beer. The barley is allowed to sprout and then dried. After this the brewer extracts the malt that has formed in the sprouting process. The residue left is wet brewers' grains. After drying they are sold as the dried grains. Due to the fact that the wet grains, both brewers' and distillers' grains were fed to dairy cows under very unsanitary conditions they came into disrepute. However, there is nothing about the dried grains that makes them at all unsatisfactory for feed. The dried brewers' grains are high in protein, low in carbohydrates and only fair in their fat content. They carry considerable of fiber. The composition is protein 20 percent, carbohydrates 32 percent, and fats 6 percent.

Gluten feed is a product that comes from corn in the manufacture of starch. The first step in the process takes out the corn germ, the next removes the outer covering and flinty part of the kernel, and the next takes away the starch or white floury part of the corn and the material left is called **gluten meal.** Very little gluten meal is sold now. This is a very concentrated feed and is not so much used as is the gluten feed, which is the gluten meal and the outer part of of the corn, or the bran, mixed together. Gluten feed is a very good dairy feed and is much used. It is high in protein, fair in carbohydrates and rather low in fat. The composition is protein 21.3 percent, carbohydrates, 52.8 percent and fats 2.9 percent.

Roughages.—This class of feeds should be of superior quality, for they are fully as important in feeding as are the concentrates. As a rule, feeders pay too little attention to the kind and quality of the roughages that they use. If possible one of the legumes, such as alfalfa or the clovers should form the base of the dairy ration. Then the cows may be allowed to clean up as much of the coarser feeds as they will eat.

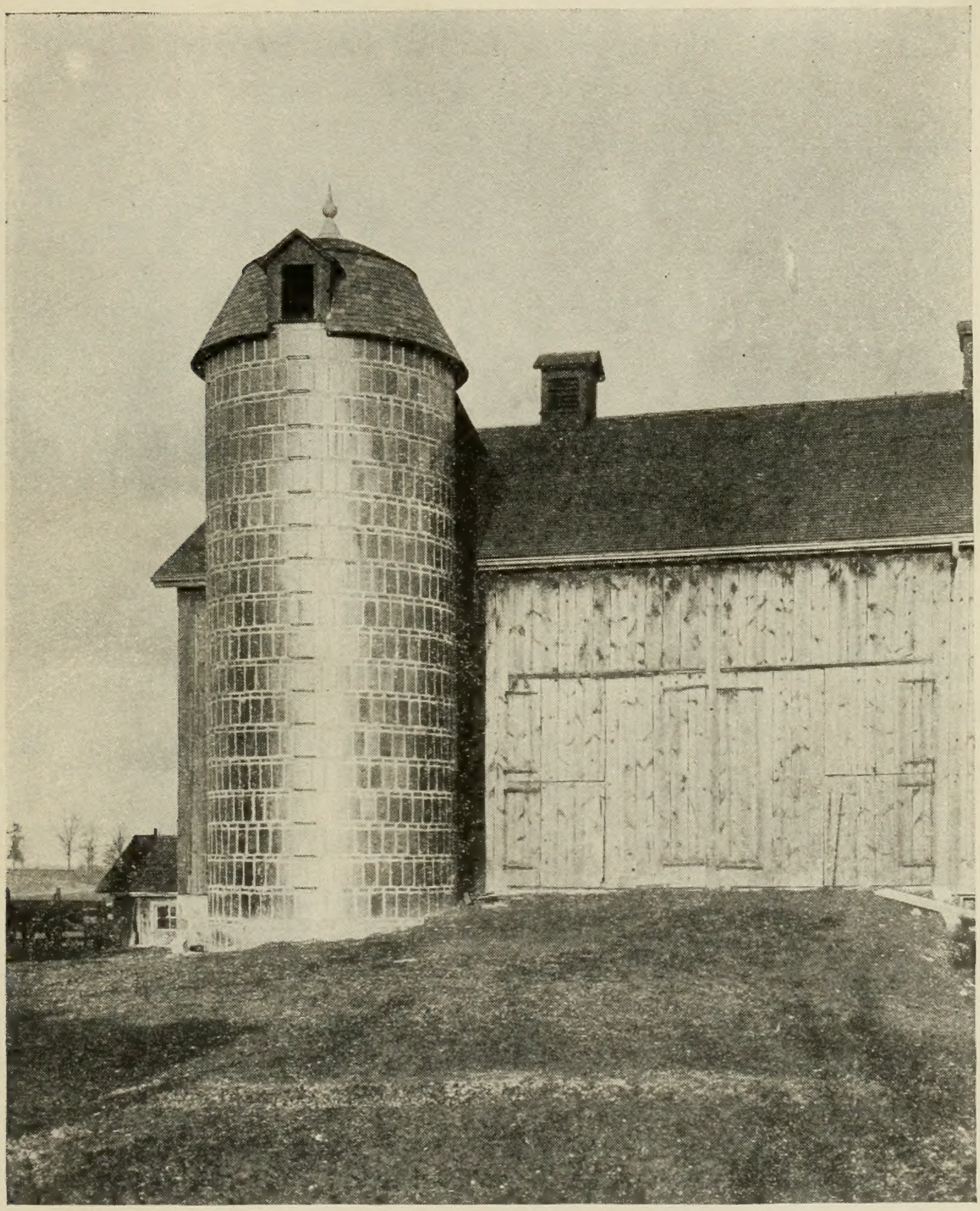
Alfalfa is considered to be one of the best of the protein roughages that we can feed. It is a new feed to most of our eastern farms, but has been used in the west for some years with great success. Experiments have shown it to be quite comparable in feeding value to bran, in the ration of dairy cows. In order to be of the most value, it should be cured in such a way that it will not shatter, as a great deal of the feeding value is in the leaves. When cut before it is too old, it will make hay having a rather small amount of fiber, about

27 percent. The composition of alfalfa hay is about 10.5 percent of protein, 40.5 percent of carbohydrates and .9 percent ot fat.

Clovers are the great legumes of the northeastern part of this country. On most all of the well regulated farms of Ohio we find this crop grown. In general the red clover is the most used, yet alsike is grown a great deal in the eastern and northeastern part of the state. The feeding value of these clovers is about the same when properly harvested. Alsike does not grow so coarse as does the red, nor does it yield so heavily. These roughages compare very favorably with alfalfa, as feeds for dairy cows, and in some cases are preferred to it. The composition of these, run about as follows: 7 percent of protein, 37.8 percent of carbohydrates, and 1.8 percent of fats.

An Ohio alfalfa field. Alfalfa is one of the best dairy cow feeds and can be grown in all sections of Ohio.

The first of the roughages, that are low in protein, to be considered should be **corn silage.** It is the great dairy feed of this country. From the standpoint of economy of production and storage there is none of the feeds that can compare with it for any kind of cattle feeding. Corn silage is made by chopping the corn plant into short lengths and preserving them in a deep and air-tight chamber. In this way the material undergoes a slight fermentation until the oxygen in the air is used. It then keeps without loss. To prevent this fermentation from becoming excessive, the silage should be packed as carefully and as firmly as possible, in order that the most of the air be expelled. In a short time the top of the silage becomes air tight and the whole mass is sealed. Because the entrance of air allows fermentation to take place, and this spoils the silage as feed, one should feed at least 2 inches from the top each day after opening. This will keep the silage fed down faster than spoiling can take place. Spoiled silage should not be fed to stock as the molds may be very harmful.



Silos are found on well equipped dairy farms.

Silage comes as near to being a substitute for summer pasture as any feed that can be used. It is succulent, palatable and easily digested.

Many experiments show it to be one of the most suitable roughages for the dairy cow, increasing production in almost every case where compared with rations made up of dry materials. It will not take the place of the protein roughages, but will supplement them better than any other feed. The composition of corn silage is approximately, 1.5 percent of protein, 14 percent of carbohydrates and 0.7 percent of fats.

Timothy hay is one of the most common roughages used for dairy cows. It is also one of the *poorest forms of roughages that can be fed.* It is about one-third fiber and is only about one-half digestible. Dairy cows have no time to break down indigestible materials, if they are to produce milk in sufficient quantities to be profitable. When compared to the legumes, it is very much lacking in protein and is not nearly so digestible. In many cases timothy can be sold and replaced with clover at a very decided advantage. The average composition is 2.8 percent of protein, 42.4 percent of carbohydrates, and 1.3 percent of fats.

Oat hay is made by cutting oats when the grain is in the milk stage and curing. When cut at the proper time it makes a very good roughage for dairy cows. In the southern states it is used in all of the best dairies. If left to get too ripe, the oats shatter considerably and the straw becomes too tough and woody. When the clover crop fails, oats for hay may be substituted with good results. The composition is approximately 5 percent of protein, 37 percent of carbohydrates, and 1.5 percent of fats.

Corn stover is that part of the corn plant left after the ears have been removed. It is commonly known as corn fodder which refers to the entire corn plant. Corn stover may be used in the ration, but should only supplment the other roughages. It contains too much fiber and is too indigestible for use alone. As a night feed it is very satisfactory. The composition is 1.4 percent of protein, 31.2 percent of carbohydrates, and .7 percent of fats.

Wheat and oat straw are often used as the only roughages for the farm milch cow. In the majority of dairies, however, these are not used except as feeds to be picked over and then used as bedding. Since the grain has been thrashed from the straw, the most nutritious part of plant has been removed. The part left is largely fiber most of which is indigestible.

AMOUNT TO FEED

There are two general rules that are usually given to regulate the amount of feed that should be given to a cow producing milk. A good one to follow is to feed the cow 1 pound of the concentrates to each 3½ pounds of milk that she produces. This will be found to meet the requirements of most cows. As a rule, they should be allowed all the roughages that they will eat. This should be divided between silage and the other roughages. From 35 to 45 pounds of silage is all that the cows of the Jersey and Guernsey breeds will eat readily. For cows of the Holstein breed one should feed from 40 to 55 pounds of silage. The cows should be allowed all the hay that they will clean up readily.

Cows are often found that will need more grain than the amount indicated. The proportion of the mixture may be left the same and a larger allowance given. If the cow begins to take on weight it is an indication that she is receiving more than is necessary and the ration should be cut down. If, however, the cow is drying off, an addition to the body fat is not to be discouraged. On the other hand, if the cow should lose weight after she has been milked for about 6 weeks, it is a clear indication that she is not receiving enough of the feed nutrients to supply the needs for milk and at the same time keep up her body weight. In this case the feed supply should be more liberal.

There is another requirement of the cow that should be met and that is for salt. This mineral should be given each day or better still be in the manger at all times. Cows can not perform their normal functions unless supplied with sufficient salt. If this is kept from them continually for several months they will become physical wrecks.

This little bulletin is not written as a complete work on this important subject, but only to lend some information about the methods of compounding rations for dairy cows.